# LB11867FV

# Variable Speed Single-phase Full-wave Pre-driver for Fan Motor

## Monolithic Digital IC

### Overview

LB11867FV is a single-phase bipolar driving motor pre-driver with the variable speed function compatible with external PWM signal. With a few external parts, a highly-efficient and highly-silent variable drive fan motor with low power consumption can be achieved. This product is best suited for driving of the server requiring large air flow and large current and the fan motor of consumer appliances.

### Features

- Single-phase Full-wave Driving Pre-driver
  ⇒ Low-saturation Drive Using External PMOS−NMOS Enables High-efficiency Low Power-consumption Drive
- Variable Speed Control Possible with External PWM Input
  ⇒ Separately-excited Upper Direct PWM (f =30 kHz) Control Method Ensures Highly Silent Speed Control
- Current Limiting Circuit Incorporated
  ⇒ Chopper Type Current Limiting Made at Startup and during Lock
- Reactive Current Cut Circuit Incorporated
  ⇒ Reactive Current before Phase Changeover is Cut, Ensuring Highly Silent and Low Power-consumption Drive
- Minimum Speed Setting Pin
  ⇒ Minimum Speed can be Set by Setting the Resistance
- Soft Start Setting Pin
- Lock Protection and Automatic Reset Circuits Incorporated
- FG (Rotation Speed Detection) Output
- Thermal Shutdown Circuit Incorporated

### Typical Applications

- Computing & Peripherals
- Industrial
- Server
- Vending Machine

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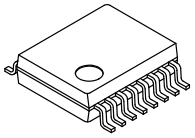
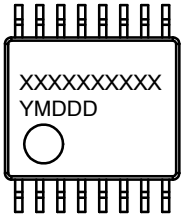


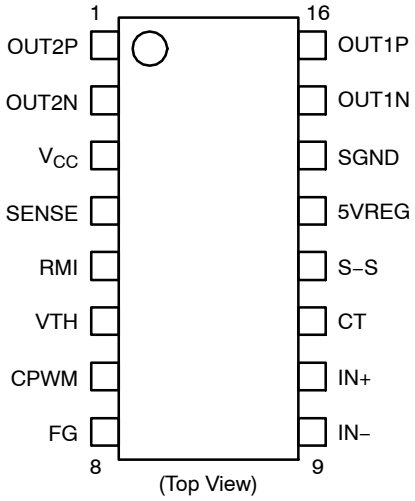
**SSOP16**
**CASE 565AM**

### MARKING DIAGRAM




XXXX = Specific Device Code
Y = Year
M = Month
DDD = Additional Traceability Data

### PIN ASSIGNMENT




### ORDERING INFORMATION

See detailed ordering and shipping information on page 9 of this data sheet.

## SPECIFICATIONS

### ABSOLUTE MAXIMUM RATINGS ($T_A$ = 25°C)

| Symbol | Parameter | Conditions | Ratings | Unit |
|---|---|---|---|---|
| $V_{CC}$ max | $V_{CC}$ Pin Maximum Supply Voltage | | 18 | V |
| IOUTN max | OUTN Pin Maximum Output Current | | 20 | mA |
| IOUTP max | OUTP Pin Maximum Sink Current | | 20 | mA |
| VOUT max | OUT Pin Output Withstand Voltage | | 18 | V |
| VVTH, VRMI max | VTH, RMI Pins Withstand Voltage | | 7 | V |
| $V_{S-S}$ max | S−S Pin Withstand Voltage | | 7 | V |
| $V_{FG}$ max | FG Output Pin Withstand Voltage | | 19 | V |
| $I_{FG}$ max | FG Pin Maximum Output Current | | 10 | mA |
| $I_{5VREG}$ max | 5VREG Pin Maximum Output Current | | 20 | mA |
| $P_d$ max | Allowable Power Dissipation | With specified substrate (Note 1) | 800 | mW |
| $T_{opr}$ | Operating Temperature | (Note 2) | −30 to 95 | °C |
| $T_{stg}$ | Storage Temperature | | −55 to 150 | °C |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Specified substrate: 114.3 mm × 76.1 mm × 1.6 mm, glass epoxy board.
2. $T_j$ max = 150°C must not be exceeded.

### RECOMMENDED OPERATING CONDITIONS ($T_A$ = 25°C)

| Symbol | Parameter | Conditions | Ratings | Unit |
|---|---|---|---|---|
| $V_{CC}$ | $V_{CC}$ Supply Voltage | | 5.5 to 16 | V |
| VTH, RMI | VTH, RMI Input Voltage Range | | 0 to 5 | V |
| VICM | Hall Input Common-phase Input Voltage Range | | 0.2 to 3 | V |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

### ELECTRICAL CHARACTERISTICS ($T_A$ = 25°C, $V_{CC}$ = 12 V)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $I_{CC}1$ | Circuit Current | During drive | 5.5 | 7.5 | 9.5 | mA |
| $I_{CC}2$ | | During lock protection | 5.5 | 7.5 | 9.5 | mA |
| 5VREG | 5VREG Voltage | $I_{5VREG}$ = 5 mA | 4.80 | 4.95 | 5.10 | V |
| VLIM | Current Limiting Voltage | | 185 | 200 | 215 | mV |
| $V_{CPWM}H$ | CPWM Pin “H” Level Voltage | | 2.8 | 3.0 | 3.2 | V |
| $V_{CPWM}L$ | CPWM Pin “L” Level Voltage | | 0.9 | 1.1 | 1.3 | V |
| $I_{CPWM}1$ | CPWM Pin Charge Current | $V_{CPWM}$ = 0.5 V | 24 | 30 | 36 | μA |
| $I_{CPWM}2$ | CPWM Pin Discharge Current | $V_{CPWM}$ = 3.5 V | 21 | 27 | 33 | μA |
| FPWM | CPWM Oscillation Frequency | C = 220 pF | − | 30 | − | kHz |
| $V_{CT}H$ | CT Pin “H” Level Voltage | | 2.8 | 3.0 | 3.2 | V |
| $V_{CT}L$ | CT Pin “L” Level Voltage | | 0.9 | 1.1 | 1.3 | V |
| $I_{CT}1$ | CT Pin Charge Current | $V_{CT}$ = 0.5 V | 1.6 | 2.0 | 2.5 | μA |
| $I_{CT}2$ | CT Pin Discharge Current | $V_{CT}$ = 3.5 V | 0.16 | 0.20 | 0.25 | μA |
| $R_{CT}$ | CT Pin Charge/Discharge Ratio | $I_{CT}1/I_{CT}2$ | 8 | 10 | 12 | times |
| $I_{S-S}$ | S−S Pin Discharge Current | $V_{S-S}$ = 1 V | 0.4 | 0.5 | 0.6 | μA |

**ELECTRICAL CHARACTERISTICS** ($T_A$ = 25°C, $V_{CC}$ = 12 V) (continued)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_O$NH | OUTN Output H-level Voltage | $I_O$ = 10 mA | – | $V_{CC}$–0.85 | $V_{CC}$–1.00 | V |
| $V_O$NL | OUTN Output L-level Voltage | $I_O$ = 10 mA | – | 0.9 | 1.00 | V |
| $V_O$PL | OUTP Output L-level Voltage | $I_O$ = 10 mA | – | 0.5 | 0.65 | V |
| VHN | Hall Input Sensitivity | $IN^+$, $IN^-$ differential voltage (including offset and hysteresis) | – | ±10 | ±20 | mV |
| $V_{FG}$L | FG Output L-level Voltage | $I_{FG}$ = 5 mA | – | 0.15 | 0.30 | V |
| $I_{FG}$L | FG Pin Leakage Current | $V_{FG}$ = 19 V | – | – | 20 | μA |
| IVTH/IRMI | VTH/RMI Pin Bias Current | CPWM = VTH/RMI = 2 V | – | – | 0.1 | μA |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

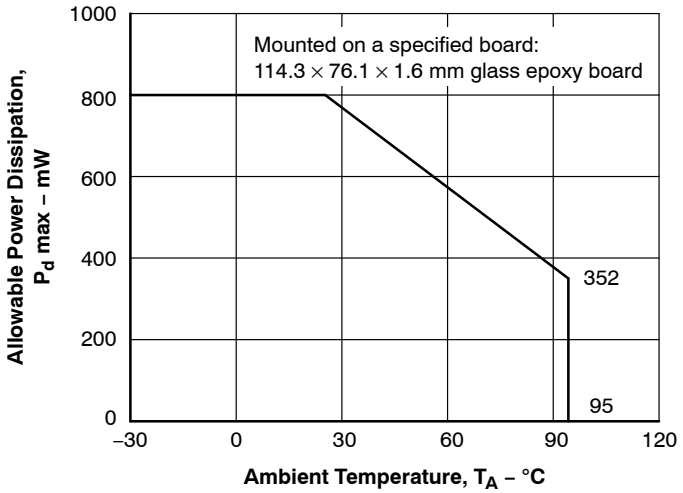



**Figure 1. $P_d$ max – $T_A$**

## BLOCK DIAGRAM

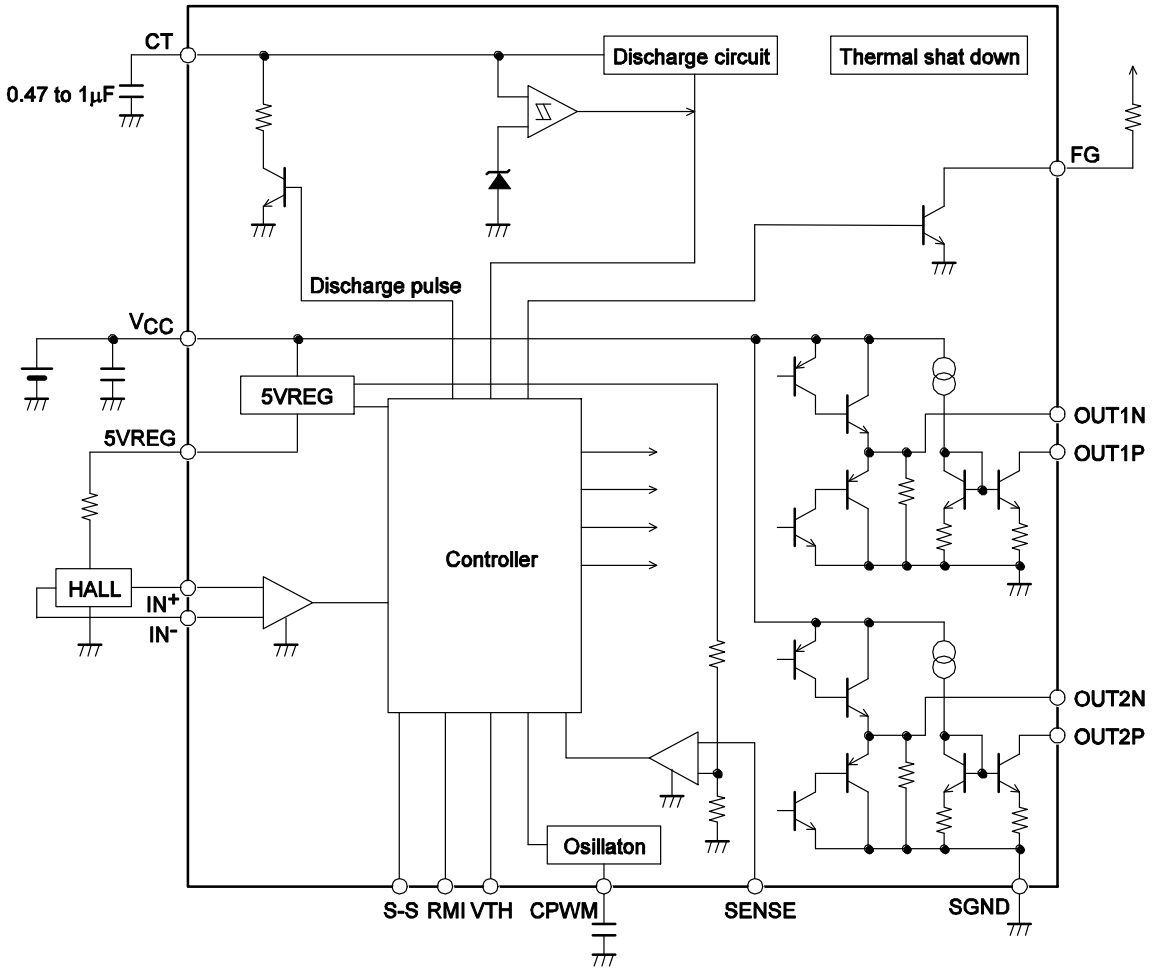



**Figure 2. Block Diagram**

**TRUTH TABLE – DRIVE LOCK CPWM = H VTH, RMI, S–S = L**

| IN– | IN+ | CT | OUT1P | OUT1N | OUT2P | OUT2N | FG | Mode |
|---|---|---|---|---|---|---|---|---|
| H | L | L | L | L | OFF | H | L | OUT1 → 2 drive |
| L | H | | OFF | H | L | L | OFF | OUT2 → 1 drive |
| H | L | H | OFF | L | OFF | H | L | Lock protection |
| L | H | | OFF | H | OFF | L | OFF | |

**TRUTH TABLE – SPEED CONTROL CT, S–S = L**

| VTH, RMI | CPWM | IN– | IN+ | OUT1P | OUT1N | OUT2P | OUT2N | Mode |
|---|---|---|---|---|---|---|---|---|
| L | H | H | L | L | L | OFF | H | OUT1 → 2 drive |
| | | L | H | OFF | H | L | L | OUT2 → 1 drive |
| H | L | H | L | OFF | L | OFF | H | Regeneration mode |
| | | L | H | OFF | H | OFF | L | |

NOTE: For VTH, RMI, and S–S pins, refer to the timing chart.

## APPLICATION CIRCUIT

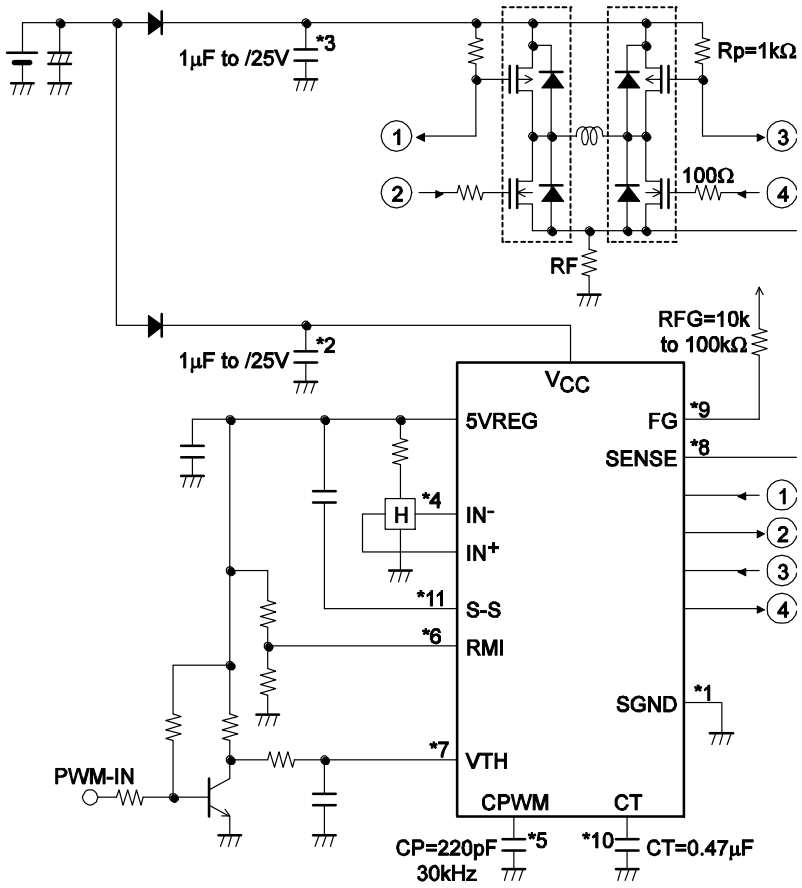



**Figure 3. Application Circuit Example (12 V)**

*1: Power-GND Wiring
SGND is connected to the control circuit power supply system.

*2: Power Stabilization Capacitor
For the power stabilization capacitor on the signal side, use the capacitance of 1 μF or more.
Connect $V_{CC}$ and GND with a thick and shortest pattern.

*3: Power Stabilization Capacitor on the Power Side
For the power stabilization capacitor on the power side, use the capacitance of 1 μF or more.
Connect the power supply on the power side and GND with a thick and shortest pattern.

*4: $IN^+$, $IN^-$ Pins
Hall signal input pin.
Wiring should be short to prevent carrying of noise.
If noise is carried, insert the capacitor between $IN^+$ and $IN^-$ pins.
The Hall input circuit functions as a comparator with hysteresis (15 mV).
This also has a soft switch section with ±30 mV (input signal differential voltage).
It is also recommended that the Hall input level is minimum 100 mV(p−p).

*5: CPWM Pin
Pin to connect the capacitor for generation of the PWM basic frequency.
The use of CP = 220 pF causes oscillation at f = 30 kHz, which is the basic frequency of PWM.
As this is used also for the current limiting canceling signal, be sure to connect the capacitor even when the speed control is not made.

*6: RMI Pin
Minimum speed setting pin.
Perform pull-up with 5VREG when this pin is not to be used.
If the IC power supply is likely to be turned OFF first when the pin is used with external power supply, be sure to insert the current limiting resistor to prevent inflow of large current.
(The same applies to the VTH pin.)

*7: VTH Pin
Speed control pin.
Connect this pin to GND when it is not used (at full speed).
For the control method, refer to the timing chart.
For control with pulse input, insert the current limiting resistor and use the pin with the frequency of 20 kHz to 100 kHz (20 kHz to 50 kHz recommended).

*8: SENSE Pin
Current limiting detection pin.
When the pin voltage exceeds 0.2 V, the current is limited and the operation enters the lower regeneration mode.
Connect this pin to GND when it is not to be used.

*9: FG Pin
Rotation speed detection pin.
This is an open collector output, which can detect the rotation speed from the FG output according to the phase changeover. Keep this pin open when it is not to be used.

*10: CT Pin
Pin to connect the lock detection capacitor.
The constant-current charge and discharge circuits incorporated cause locking when the pin voltage becomes 3.0 V and unlocking when it is 1.1 V.
Connect the pin to GND when it is not to be used (locking not necessary).

*11: S−S Pin
Pin to connect the soft-start setting capacitor.
Connect the capacitor between 5VREG and S−S pin.
This pin enables setting of the soft start time according to the capacity of the capacitor.
See the timing char.
Connect the pin to GND when it is not to be used.

## CONTROL TIMING CHART (SPEED CONTROL)

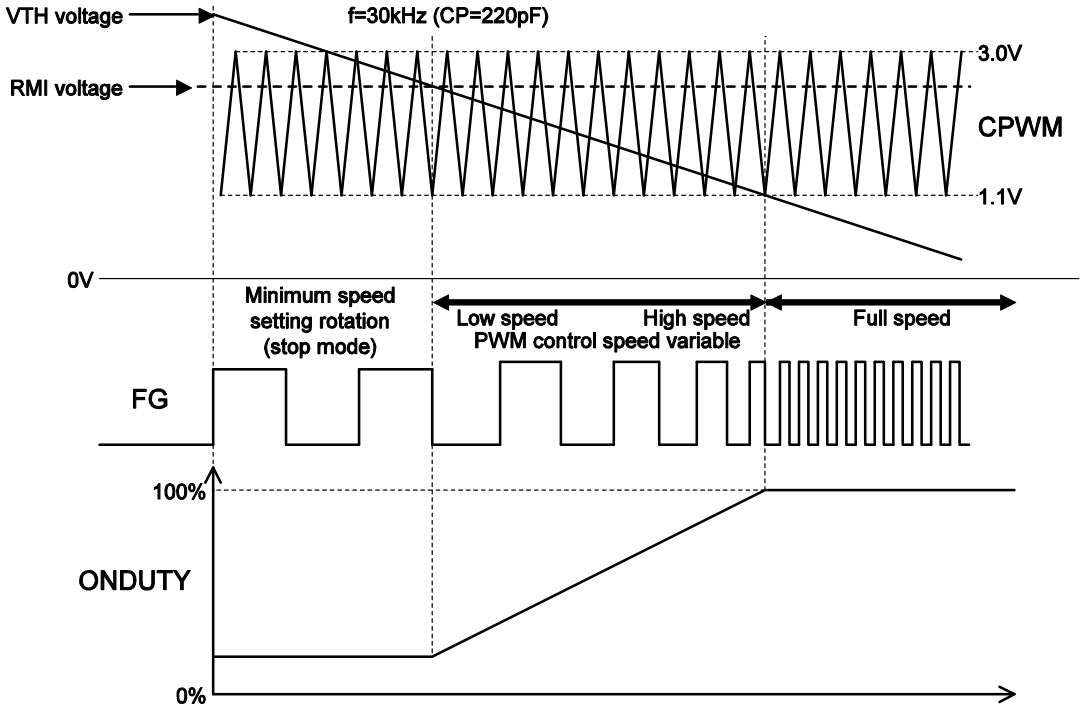



**Figure 4. Control Timing Chart – Speed Control**

1. Minimum Speed Setting (Stop) Mode
   The low-speed fan rotation occurs at the minimum speed set with the RMI pin. When the minimum speed is not set (RMI pin pulled up to 5VREG), the motor stops.
2. Low Speed ⇔ High Speed
   PMW control is made by comparing the CPWM oscillation voltage (1.1 V ⇔ 3.0 V) and VTH voltage.
   Both upper and lower output TRs are turned ON when the VTH voltage is low. The upper output TR is turned OFF when the VTH voltage is high, regenerating the coil current in the lower TR. Therefore, as the VTH voltage decreases, the output ON-DUTY increases, causing increase in the coil current, raising the motor rotation speed. The rotation speed can be monitored with the FG output.
3. Full Speed Mode
   The full speed mode becomes effective when the VTH voltage is 1.1 V or less. (Set VTH = GND when the speed control is not to be made)

## CONTROL TIMING CHART (SOFT START)

1. At VTH < RMI Voltage

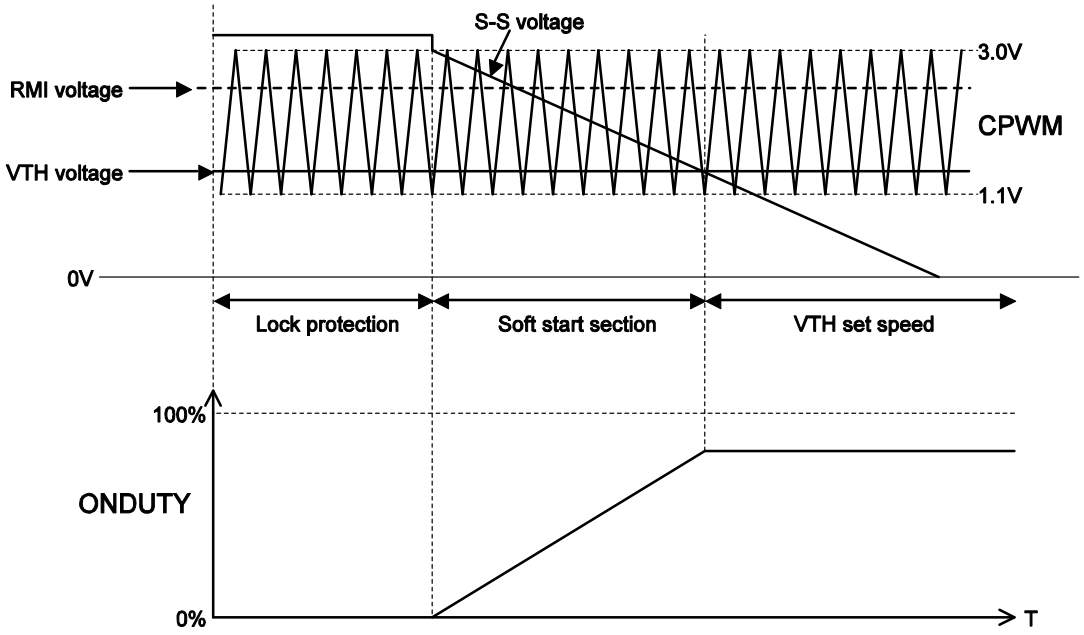



**Figure 5. At VTH < RMI Voltage**

2. At VTH > RMI Voltage

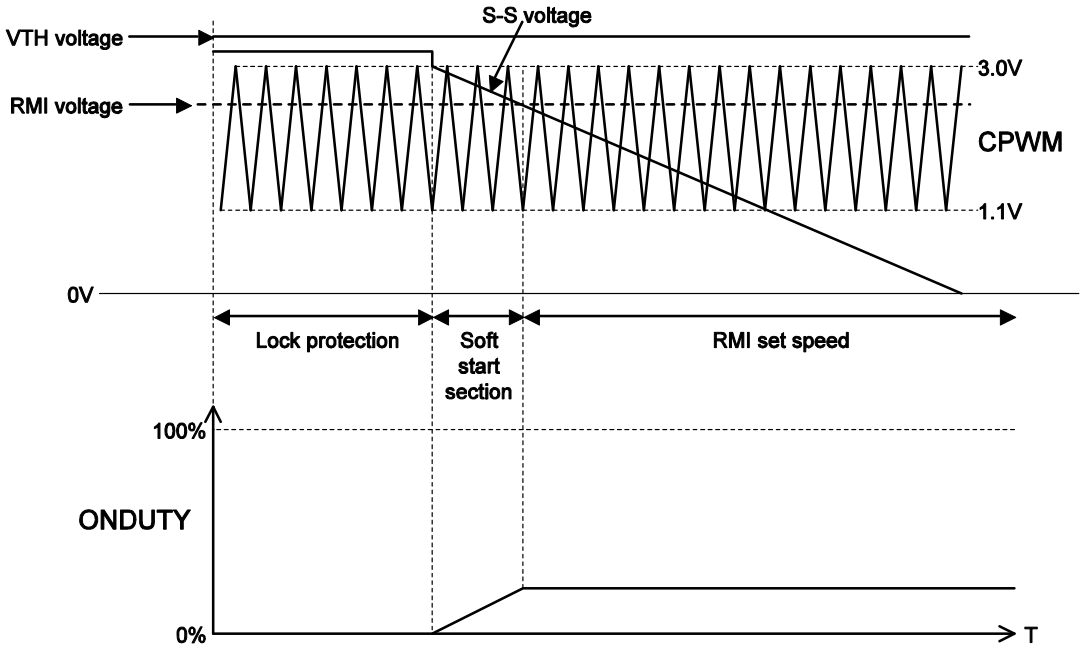



**Figure 6. At VTH > RMI Voltage**

Adjust the S−S pin voltage gradient by means of the capacitance of the capacitor between the S−S pin and 5VREG.
Recommended capacitor: 0.1 μF to 1 μF

## ORDERING INFORMATION

| Device | Package | Wire Bond | Shipping† (Qty / Packing) |
|---|---|---|---|
| LB11867FV−MPB−E | SSOP16 (225mil)<br>(Pb−Free) | Au−wire | 90 / Fan−Fold |
| LB11867FV−MPB−H | SSOP16 (225mil)<br>(Pb−Free / Halogen Free) | Au−wire | 90 / Fan−Fold |
| LB11867FV−TLM−E | SSOP16 (225mil)<br>(Pb−Free) | Au−wire | 2,000 / Tape & Reel |
| LB11867FV−TLM−H | SSOP16 (225mil)<br>(Pb−Free / Halogen Free) | Au−wire | 2,000 / Tape & Reel |
| LB11867FV−W−AH | SSOP16 (225mil)<br>(Pb−Free / Halogen Free) | Cu−wire | 2,000 / Tape & Reel |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

# MECHANICAL CASE OUTLINE
## PACKAGE DIMENSIONS

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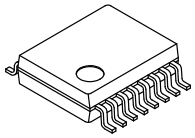
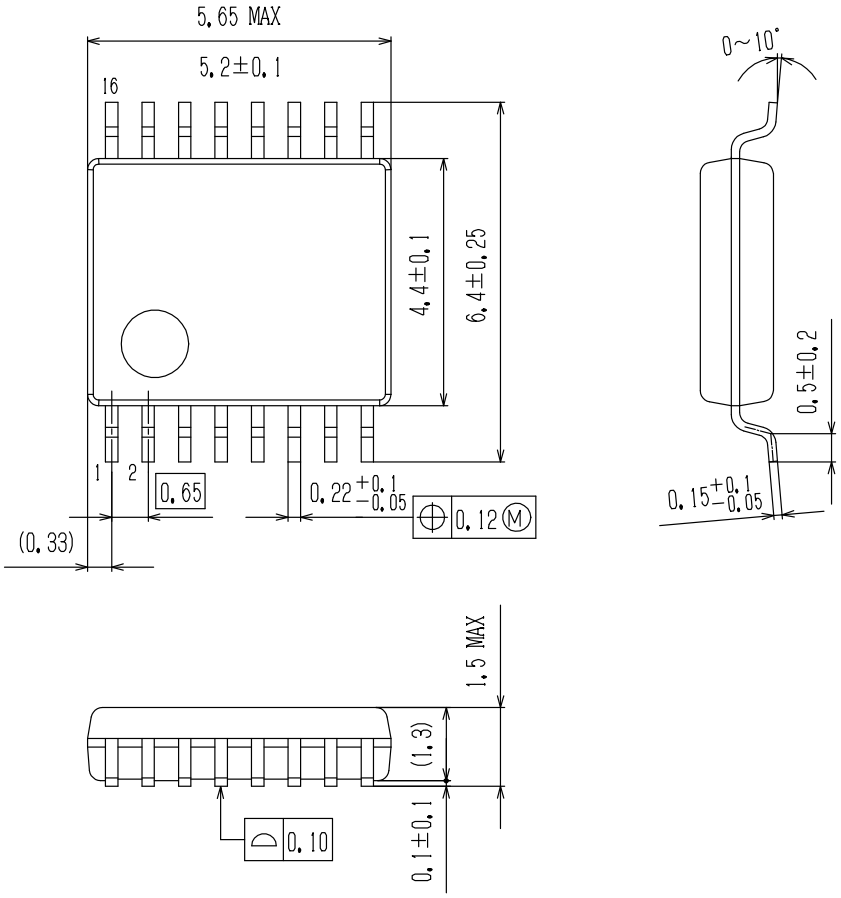
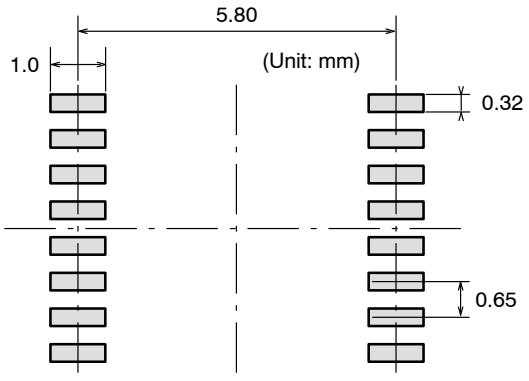


**SSOP16 (225mil)**
CASE 565AM
ISSUE A

DATE 23 OCT 2013



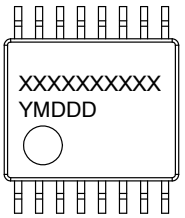

### SOLDERING FOOTPRINT*




NOTE: The measurements are not to guarantee but for reference only.

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

### GENERIC MARKING DIAGRAM*




XXXXX = Specific Device Code
Y = Year
M = Month
DDD = Additional Traceability Data

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, “G” or microdot “ ▪”, may or may not be present.

| | | | |
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| ISSUE | REVISION | DATE |
|---|---|---|
| O | RELEASED FOR PRODUCTION FROM SANYO ENACT# S−010 TO ON SEMICONDUCTOR. REQ. BY D. TRUHITTE. | 30 JAN 2012 |
| A | ADDED MARKING AND SOLDER FOOTPRINT INFORMATION. REQ. BY D. TRUHITTE. | 23 OCT 2013 |
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